PTO/PCT Rec'd 08 DEC 2000
09/719338
WO 99/63925 PCT/US99/13174

UNITARY ABSORBENT STRUCTURE CONTAINING SUPERABSORBENT POLYMER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority under 35 U.S.C. 119 based upon U.S. Provisional Application Serial No. 60/088,454 filed June 8, 1998, the entire disclosure of which is hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention relates to fibrous absorbent structures containing superabsorbent polymers useful in the manufacture of disposable diapers, adult incontinence pads, sanitary napkins and the like. More particularly, the invention is directed to an absorbent structure having sealed lateral edges to contain loose fibers and particles within the structure.

BACKGROUND OF THE INVENTION

Absorbent articles such as disposable diapers, adult incontinence pads, sanitary napkins and the like are generally provided with an absorbent core to receive and retain bodily liquids. The absorbent core is usually sandwiched between a liquid pervious top sheet, whose function is to allow the passage of fluid to the core, and a liquid impervious backsheet whose function is to contain the fluid and to prevent it from passing through the absorbent article to the garment of the wearer of the absorbent article.

An absorbent core for diapers and adult incontinence pads frequently includes fibrous batts or webs constructed of defiberized, loose, fluffed, hydrophilic, cellulosic fibers. The core may also include superabsorbent polymer (SAP) particles, granules, flakes or fibers. This core is typically referred to as a storage layer.

In recent years, market demand for an increasingly thinner and more comfortable absorbent article has increased. Such an article may be obtained by decreasing the thickness of the diaper core, by reducing the amount of fibrous material used in the core while increasing the amount of SAP particles, and by calendaring or pressing the core to reduce caliper and hence, increase density.

Such higher density cores do not absorb liquid as rapidly as lower density cores because densification of the core results in smaller effective pore size. Accordingly, to maintain suitable liquid absorption, it is necessary to provide a lower density layer having a larger pore size above the high density absorbent core to increase the rate of uptake of liquid discharged onto the absorbent article. The low density layer is typically referred to as an acquisition layer. Multiple layer absorbent core designs involve a more complicated manufacturing process.

The storage layer portion of a disposable diaper for example, is generally formed in place, during the converting process, from loose, fluffed cellulose. Such cellulose material is generally not available in preformed roll form because it exhibits insufficient web strength, owing to its lack of interfiber bonding or entanglement, to be unwound directly onto and handled in absorbent pad-making equipment.

Ultra-thin feminine napkins are generally produced from roll-goods based nonwoven material. Such a roll of preformed absorbent core material is unwound directly onto the absorbent article converting equipment without the defiberization step required for fluff-based products, such as diapers and incontinence pads. The nonwoven web is typically bonded or consolidated in a fashion that gives it sufficient strength to be handled in the converting process. These webs may also contain SAP particles.

The web consolidation mechanisms used in the roll-goods approach to making preformed cores provide strength and dimensional stability to the web. Such mechanisms include latex bonding, bonding with thermoplastic or

bicomponent fibers or thermoplastic powders, hydroentanglement, needlepunching, carding or the like.

However, while the web may be strengthened sufficiently for roll-goods converting, the strengthened web also constrains the swelling of SAP particles as the particles are trapped in the interstitial spaces of the web. The particles are unable to expand due to its increased strength and dimensional stability of the surrounding web. As a result, the ultimate absorbent capacity of the structure is diminished. In turn, higher basis weight and/or lower density absorbent core structures are required to provide the absorbent capacity required for high discharge volume products such a baby diapers and adult incontinence pads. Moreover, at high particle loadings such core structures exhibit poor particle containment. In other words, some of the particles tend to escape from the structure during manufacture, handling, shipping and converting. This can result in the fouling of manufacturing and converting equipment.

With regard to conventionally produced, absorbent structures, reference is made to U.S. Patent Nos. 5,009,650, 5,378,528, 5,128,082, 5,607,414, 5,147,343, 5,149,335, 5,522,810, 5,041,104, 5,176,668, 5,389,181, and 4,596,567, the disclosures of which are hereby incorporated by reference.

There is a need for an absorbent core material which facilitates fluid transport from an acquisition zone to a storage zone, exhibits good particle containment at high particle loading, is thin but has a high absorbent capacity in use, and can be delivered in roll-goods form to simplify the manufacturing and converting processes.

SUMMARY OF THE INVENTION

The present invention is directed to a unitary absorbent structure, including an upper fibrous layer having a liquid acquisition zone extending to one surface and a liquid distribution zone extending to the other surface. A lower fibrous liquid storage layer is in liquid

communication with the distribution zone surface of the upper layer. The storage layer includes SAP particles. A containment layer surrounds the storage layer and extends to the outer edges of the structure, the containment layer contains the fibers and SAP particles of the storage layer against the distribution zone surface of the upper layer.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-section of a preferred unitary absorbent structure of the present invention.

FIG. 2 is a bottom view of the structure of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a stratified, unitary absorbent core structure having a density gradient through the thickness of the structure. The structure is a composite including at least two zones which confer upon the structure the ability to distribute fluids through the density gradient. These zones include an upper acquisition zone capable of rapidly acquiring liquid from insult, a distribution zone for laterally distributing the acquired liquid, and a storage zone for absorbing and storing the distributed liquid from the distribution zone and which has the capability to swell in the Z-direction to maximize the absorbent capacity of the material employed. The structure is sealed around its lateral edges to improve containment of unbonded or lightly bonded fibers or particles within the structure. Sealing may be accomplished by optionally providing a separate containment layer impermeable to loose fibers or loose particles, positioned below the storage zone of the structure.

The absorbent structure has the absorbent capacity of an unbonded airfelt structure with improved particle containment and may be delivered in roll-goods form, and is particularly useful as an absorbent core for disposable absorbent articles such as diapers, adult incontinence pads and briefs, and feminine sanitary napkins.

With reference to the drawings, the absorbent structure of the present invention includes a multilayer fibrous structure 10, having acquisition 2, distribution 4 and storage 14 zones. The acquisition and distribution zones of the structure are provided by acquisition - distribution layer 12 (ADL) which can be preformed or formed concurrently with the storage layer. The bonded structure may be formed by airlaid, wetlaid, thermobonding, carding or like techniques. The storage zone of the structure is provided by an airfelt layer of cellulosic fiber 6. The storage zone also includes SAP particles, granules or fibers 18. As used herein, an airfelt layer is a layer of airlaid fibers which are not bonded together. Because the airfelt layer has low web strength, it is formed by directly airlaying the cellulose fibers blended with SAP particles onto the distribution zone side 4 of the ADL 12. The structural integrity of the resultant ADL-airfelt structure is maintained by sealing the airfelt layer to the ADL. The seal is provided at such locations which will form the lateral edges of the absorbent core during converting. Preferably, a containment layer 8 is provided over the exposed surface of the airfelt layer of the structure. The containment layer is sealed to the structure to contain fibers 6 and particles 18. At the same time the containment layer is sealed to the structure to provide sufficient volume for the storage zone and SAP to swell without or substantially without constraint in the Z-direction.

<u>The Acquisition-Distribution Layer</u>

Preferably, the ADL of the present invention is a nonwoven structure having at least two discrete layers. The layer of the ADL closest to the wearer of the absorbent product (the top or acquisition layer) has a fiber content comprised entirely of modified cellulose or synthetic fibers and a binder resin. The layer of the ADL closest to the liquid storage (bottom) layer of the absorbent structure(the distribution layer) has a fiber content comprised primarily of air laid-fluff cellulose, chemically modified cellulose

fibers, crosslinked cellulose fibers, cotton linter fibers or mixtures thereof. The basis weight of each layer preferably ranges from 15 to 60 gsm for a total ADL basis weight of 30 to 120 gsm. Optionally, middle layers may be included. Such middle layers may have a fiber composition that is 100% fluff cellulose and/or chemically modified cellulose fibers or have a fiber composition that is a blend of synthetic fibers and cellulose fibers.

In a preferred embodiment, the acquisition layer side of the ADL is 80-90% by weight 6.7 wt/length of fiber dtex in size by 6mm in cut length polyester (PET) fiber bonded with 10-20% by weight of latex. The bottom or distribution layer is 80-90% fiberized fluff cellulose fibers bonded with 10-20% of an aqueous binder. The total basis weight of the ADL is 60 to 80 gsm and the top synthetic fiber layer is 25 to 50% of the total basis weight of the ADL. The fiberized fluff cellulose fibers may be selected from wood cellulose such as Foley fluff, cotton linter pulp, chemically modified cellulose such as crosslinked cellulose fibers or highly purified cellulose fibers, such as Buckeye HPF (each available from Buckeye Technologies, Inc., Memphis, Tennessee).

In an alternate preferred embodiment, the top layer and bottom layers of the ADL have the same composition as above, and also includes a middle layer of a blend of PET and cellulosic fibers. In this embodiment the top layer is at least 10% of the total ADL weight and the bottom layer is no more 50% of the total ADL basis weight.

The Storage Layer

As discussed above, the storage layer is preferably made from fiberized fluff cellulose fibers. Most preferred is wood cellulose such as Foley fluff. Also preferred is cotton linter pulp, chemically modified cellulose such as crosslinked cellulose fibers and highly purified cellulose fibers, such as Buckeye HPF (each available from Buckeye Technologies, Inc., Memphis,

Tennessee). The fluff fibers may be blended with synthetic fibers such as polyester such as PET, nylon, polyethylene or polypropylene. In addition, bicomponent thermoplastic fibers may be blended with the cellulose or synthetic fibers. The preferred thermoplastic fiber is Celbond Type 255 Bico fiber from Hoechst Celanese. The Bico fiber has a polyester core and an activated co-polyolefin sheath.

Airlaid Manufacture of the Absorbent Core

Preferably, the ADL is prepared as an airlaid web. The airlaid web is typically prepared by disintegrating or defiberizing a cellulose pulp sheet or sheets, typically by hammermill, to provide individualized fibers. The individualized fibers are then air conveyed to forming heads on the airlaid web forming machine. Several manufacturers make airlaid web forming machines, including M&J Fibretech of Denmark and Dan-Web, also of Denmark. The forming heads include rotating or agitated drums, generally in a race track configuration which serve to maintain fiber separation until the fibers are pulled by vacuum onto a foraminous condensing drum or foraminous forming conveyor (or forming wire). In the M&J machine, the forming head includes a rotary agitator above a screen. Other fibers, such as a synthetic thermoplastic fiber, may also be introduced to the forming head through a fiber dosing system which includes a fiber opener, a dosing unit and an air conveyor. Where two defined layers are desired, such as a fluff pulp distribution layer and a synthetic fiber acquisition layer, two separate forming heads are provided, one for each type of fiber.

The storage layer is preferably manufactured in airfelt form. As discussed above, an airfelt is made using airlaid equipment but no separate binders are employed. As contemplated for the present invention, a forming head of the airlaid web forming machine distributes the desired fiber for the storage zone of the absorbent core onto the ADL layers. Preferably, this fiber is a cellulose fluff. SAP granules are blended with the fluff to be distributed by

the forming head or are separately applied to the airfelt web by a dosing head. In addition to SAP, other functional particulates may be included in the airfelt. Such particulates include odor control agents, e.g., zeolites, fragrances, and the like.

The airlaid web is transferred from the forming wire to a calender or other densification stage to densify the web, increase its strength and control web thickness. The fibers of the web are then bonded by application of a latex spray or foam addition system, followed by drying or curing. Alternatively, or additionally, any thermoplastic fiber present in the web may be softened or partially melted by application of heat to bond the fibers of the web. The bonded web may then be calendered a second time to increase strength or emboss the web with a design or pattern. If thermoplastic fibers are present, hot calendering may be employed to impart patterned bonding to the web. Water may be added to the web if necessary to maintain specified or desired moisture content, to minimize dusting and to reduce the buildup of static electricity. The finished web is then rolled for future use.

Alternatively, to assemble the ADL and the airfelt layers, one can form the airfelt layer on the airlaid line. A previously manufactured airlaid ADL is unwound upstream of the airfelt layer forming and dosing heads. The containment layer is then unwound onto the airfelt layer. Next, the containment layer is sealed to contain the airfelt layer, SAP and other particulates.

<u>The Containment Layer</u>

The containment layer is intended to retain in place the unbonded or lightly bonded airfelt storage layer containing SAP and optionally other particles. The containment layer should retain but not constrain the fibers and SAP particles of the storage layer from swelling in the Z-direction upon liquid absorption. The containment layer need not serve as an absorbent layer and in fact it can also serve as a liquid impermeable bottom sheet. Suitable

materials for the containment layer include thermoplastic film, carded nonwoven or woven tissues, and the like. Examples of suitable thermoplastics include polyethylene and polypropylene.

The containment layer may be sealed to the absorbent structure in several ways. The containment layer may be made from a thermoplastic material which can be selectively heat sealed to the structure at desired locations. Alternatively, the containment layer may be sealed to the structure by applying a pressure sensitive or hot melt adhesive to the structure at desired seal locations before the containment layer is applied. A latex or other binder may also be employed as an adhesive. Ultrasonic welding may also be used to seal the containment layer to the structure. If a thermoplastic fiber is present in the storage layer, it may be used to seal the containment layer to the storage layer by the application of localized heat where seal formation is desired. The containment layer should not compress or otherwise constrain the underlying storage layer during sealing to an extent which would constrain the swelling of the storage layer upon absorption of liquid.

The absorbent core contemplated by the present invention is generally cut to rectangular, hourglass, T-shape, or other nested shapes, for use in diapers, adult incontinent pads and feminine hygiene pads. To form the seals at each edge of the rectangular core, it is preferred that the longitudinal seals (in the machine direction of the roll), be applied to the web, by for example a ribbed, heated calender to form heat seals along the web spaced apart the desired width of the absorbent core. The web is then slit in the machine direction at the heat seal to form separate webs of the desired absorbent core width, each narrow web having a heat seal along both edges. The narrow webs are then subjected to the application of spaced apart heat seals in the cross direction. In this manner, the slitting knives may divide a heat seal into two and avoid wasting material or leaving an exposed, non-sealed edge.

The heat seals to be slit must be of sufficient width to provide two effective seals after slitting. The spacing of these seals is determined by the desired length of the final absorbent core. Finally, the narrow web may be cut at the cross direction heat seal to form individual absorbent cores ready for conversion to the final product. Preferably, however, the narrow webs are not cut (although the cross direction heat seals may be perforated) and are rolled for shipment to the conversion site.

Wetlaid Manufacture of the Absorbent Core

Although airlaid web manufacturing methods are preferred for manufacturing the absorbent core of the present invention, wetlaid methods may alternatively be employed. To prepare the structure a multiple head box paper machine employing delta formers is used. The first head box distributes the acquisition zone fiber. The second head box distributes the distribution zone fiber. The resultant web is then passed through a dryer section before application of the storage zone fiber and SAP by airlaying. A containment layer is then applied to the structure and seal provided as discussed above.